Earthquake and Fire Following Catastrophe Update

CAS Spring Meeting, May 19 – 22, 2013

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Agenda

- Advancements in fire following earthquake modeling
  - Overcoming limitations of empirical data
  - Transitioning from empirical models to physical models
  - Continuously improving model data quality and coverage
- AIR's innovations for regional scale modeling of fire following risk
  - Capturing the risk of fire spreading based on building configuration
  - Modeling countrywide-risk at a high resolution
- Fire following earthquake risk example: Vancouver, B.C.

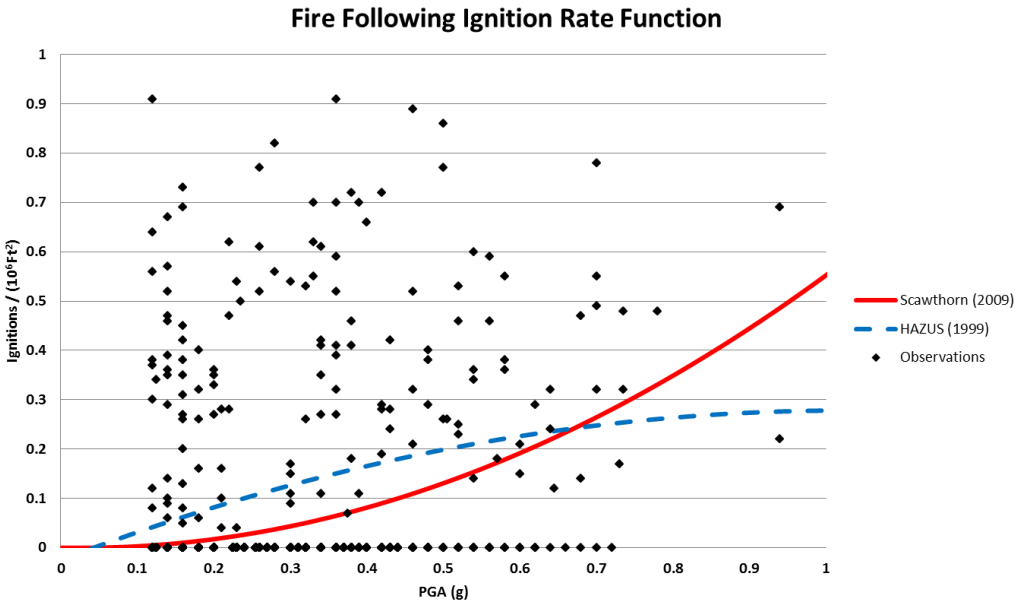
Lack of Empirical Data Creates Limitations for Fire Following Modeling

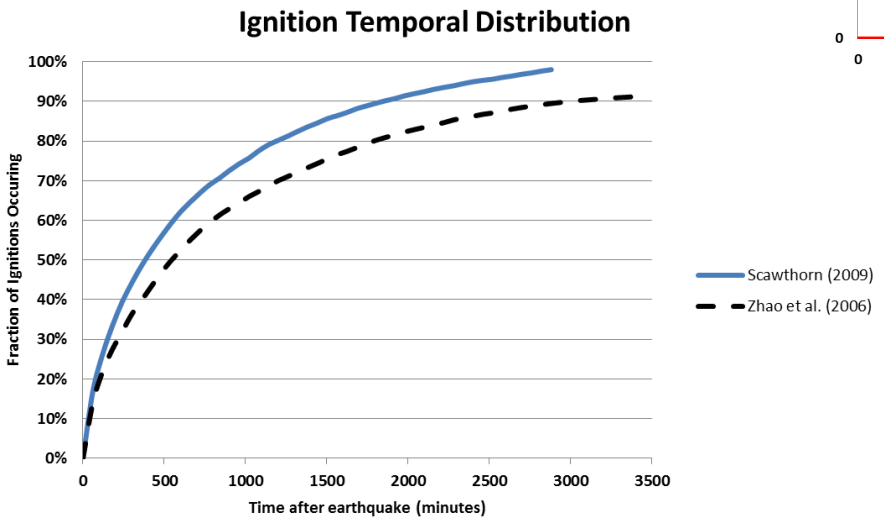
- Only a handful of fire following events occurred globally within the last century, and, for many of these, data is scarce or outdated

US Archive ARCWEB ARC Identifier: 524396 NARA National Archives and Records Administration

Recent Improvements Have Been Made in Modeling Fire Following Ignitions

- Davidson (2009) and Scawthorn (2009) re-evaluated historical ignition information in the context of "zero-ignition-data"

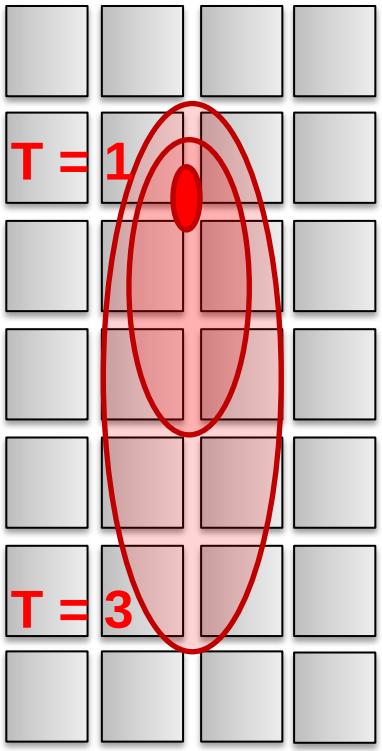


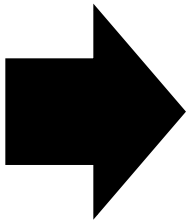


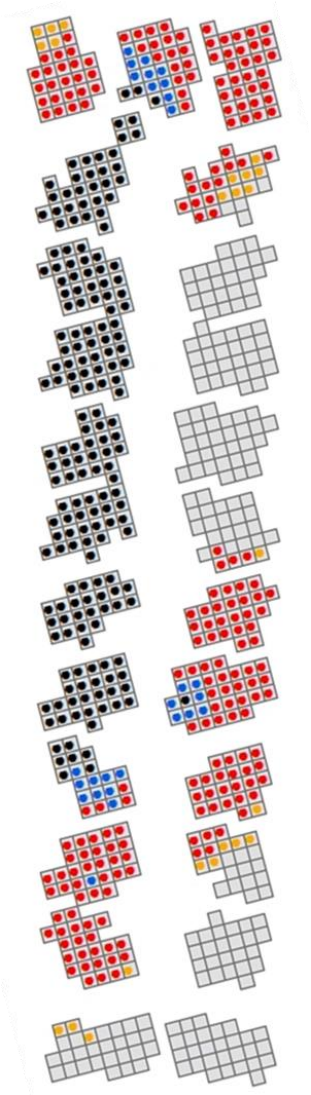
- Scawthorn (2009) and Zhao (2006) quantified post-earthquake ignition timing

To Better Capture the Risk, the Models Must Transition from Empirical to Physical Models

- Leading edge fire following models have transitioned from empirically derived elliptical spread equations to cellular automata, and physics-based models

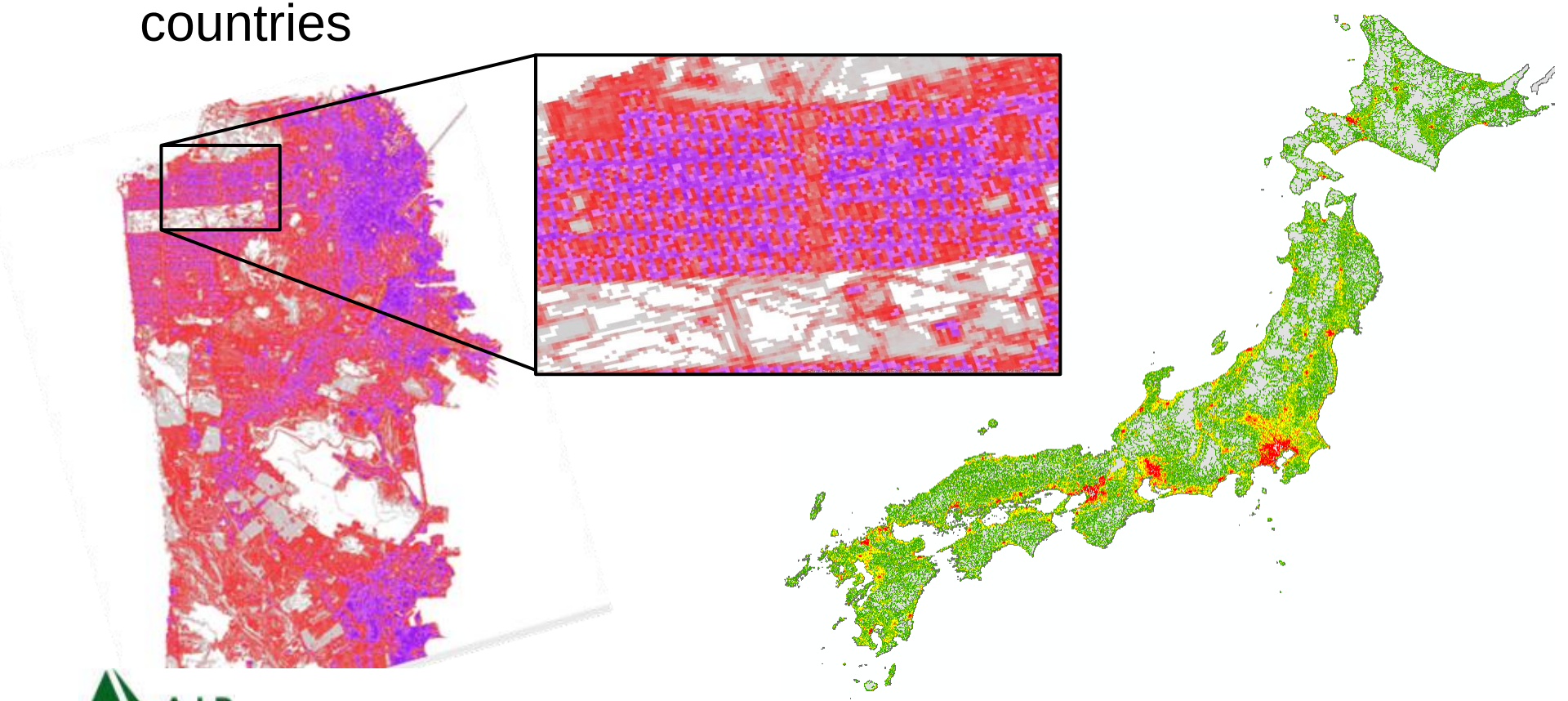






Resolution and Quality of Spatial Data Is Continuously Improving

- Data critical to fire following models such as land use / land cover and street widths are now available countrywide at a resolution of 1 km or finer for some countries

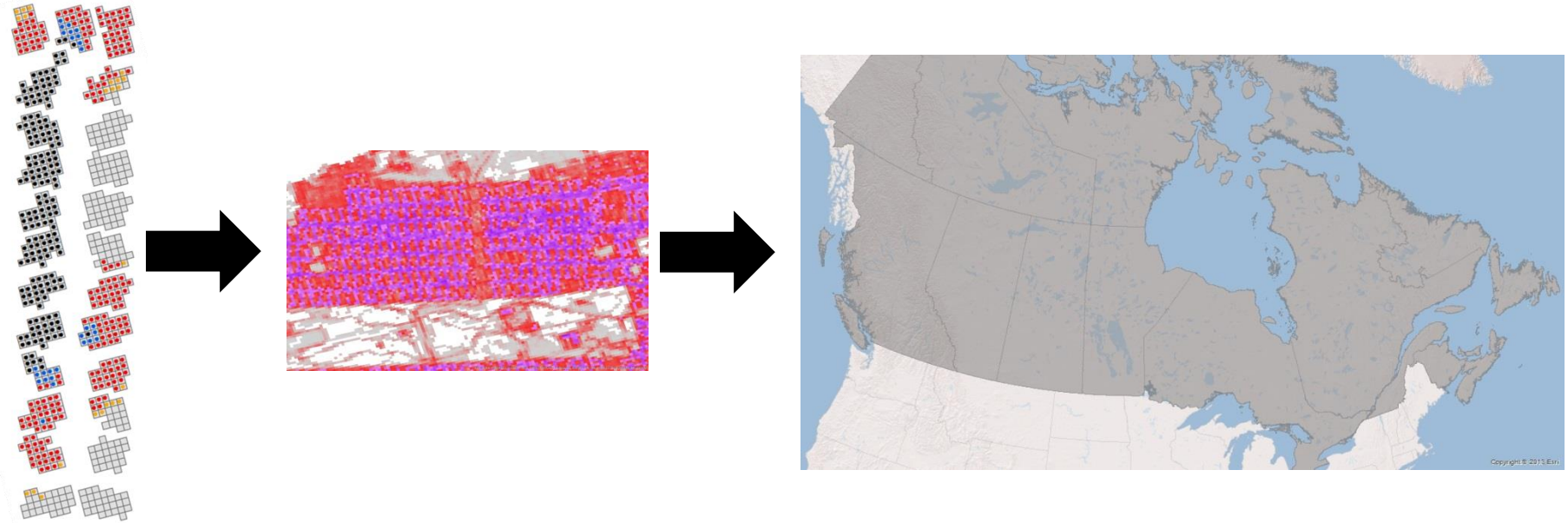


Despite Recent Advances, Challenges Remain for Creating a Regional Fire Following Model

Model Resolution

Data Resolution

Countrywide Modeling Resolution



- Detailed cellular automata and physics-based fire following models are currently only applicable at the city scale
- Processing thousands of events for an entire region is still computationally challenging

AIR Is Developing Innovations for Modeling Fire Following Risk at a Regional Scale

Characteristic Blocks

Google Maps

Google Imagery

Building Distribution Modeling

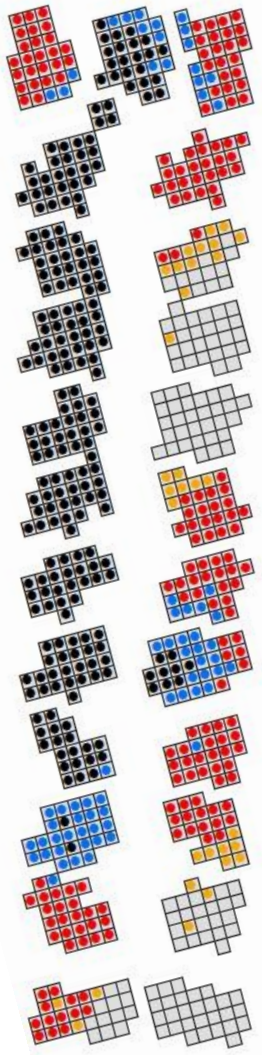
Google Maps

Using Characteristic Blocks Enables the Model to Approximate Building Distributions

- Characteristic blocks enable analysis on a few dozen blocks to be applied countrywide
- The blocks allow for realistic variations in building spacing, size, height, combustibility and occupancy type
- As a result, we can more accurately model fire spread between buildings

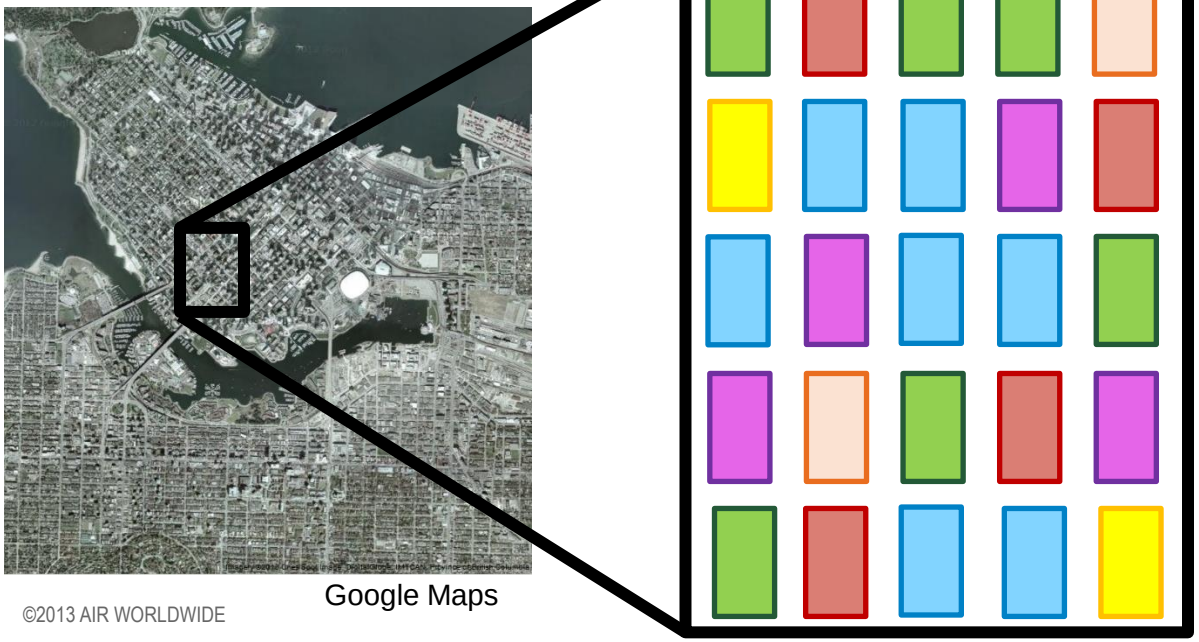
Cellular Automata Model Realistically Captures the Way Fires Spread on Characteristic Blocks

- The AIR model uses a cellular automata model to evaluate fire spread behavior on each of the characteristic blocks
- Fire spread methods include
  - Direct contact
  - Sparking (piloted ignition)
  - Branding
  - Spontaneous ignition
  - Spontaneous ignition through windows
- Fire behavior is evaluated with 1,000 simulations for each characteristic block



Optimizing the Characteristic Block Distribution within Each 1 km Grid Cell

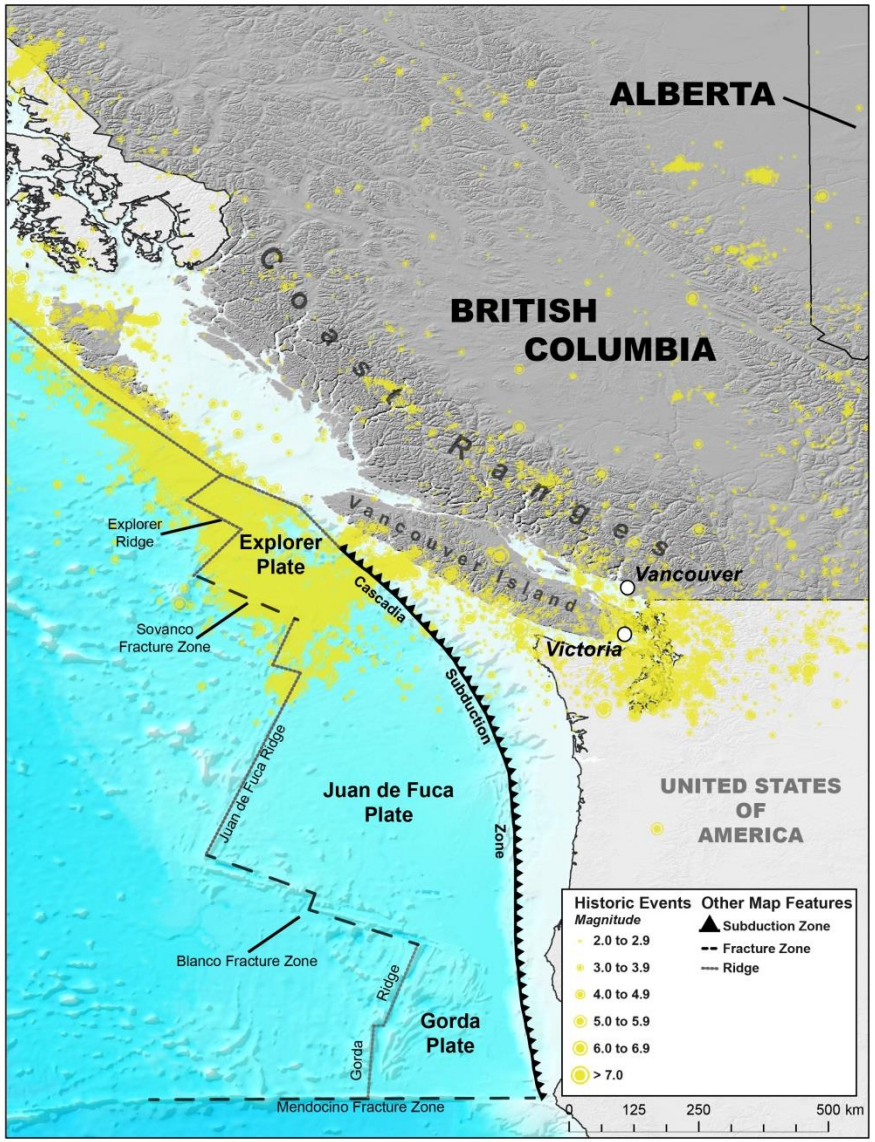
- Characteristic blocks are distributed on countrywide 1 km grid based on land use data and building census information
- Parks and open space are assigned their own block type, and represent barriers to fire spread
- Characteristic block distributions are varied stochastically to account for uncertainty



Google Maps

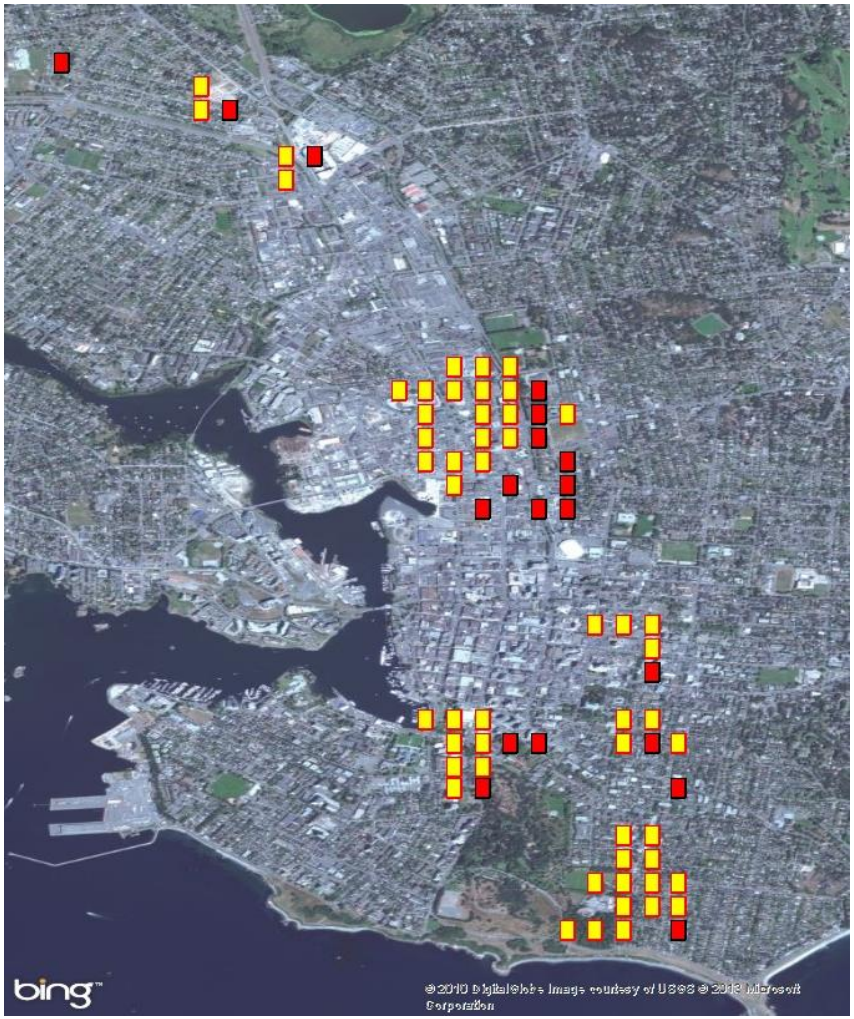
Evaluating Fire Following Risk for Vancouver in the Event of a Cascadia Subduction Zone Earthquake

- The Cascadia subduction zone is capable of generating a Magnitude 9.0 or greater earthquake near British Columbia
- Over $1 trillion of insurable exposure would be at risk in the Greater Vancouver region of British Columbia



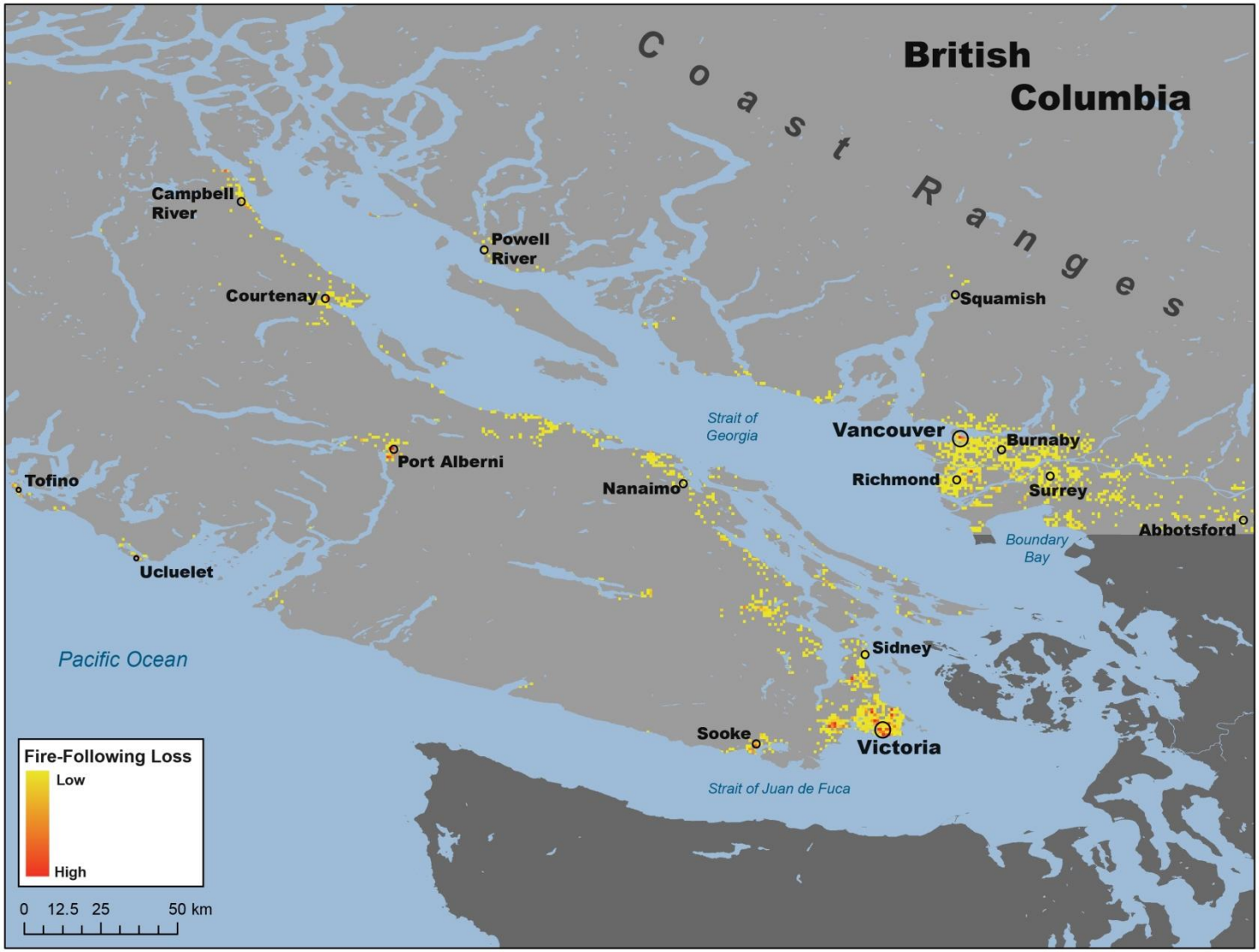
Much of the Vancouver Region Is Subject to Risk of Ignitions

Fire Department Response Is Critical to Controlling Fire Spread



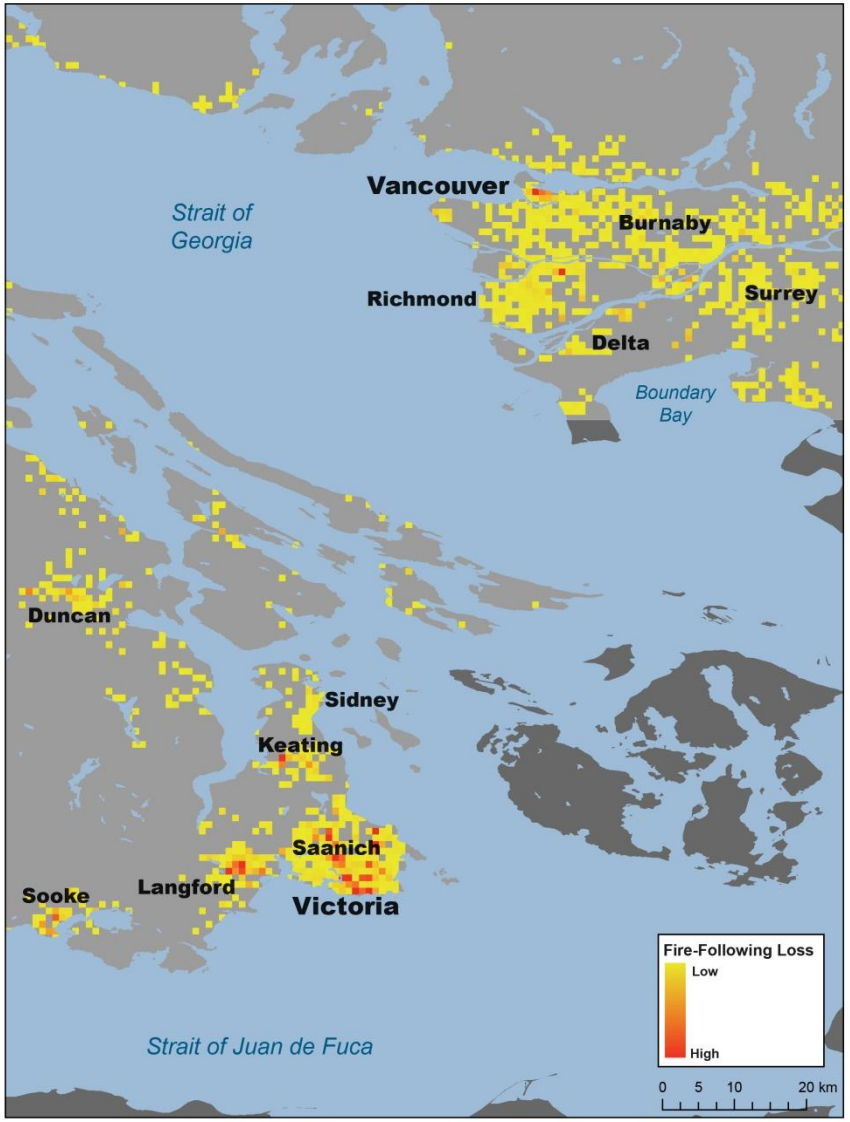
- Some ignitions may be suppressed quickly, before the fire damages more than one or two rooms in a building
- Other fires may spread to multiple buildings, or even multiple blocks, if suppression resources are unavailable to control the fire

Estimated Fire Following Losses from a Cascadia Subduction Zone Earthquake



Largest Fire Following Losses Occur in Regions with High Building Density and Strong Ground Motion

- Fully understanding the fire following risk for Vancouver requires examining thousands of possible earthquakes and the subsequent fires



AIR Earthquake Model for Canada Captures a Comprehensive View of Fire Following Risk

- The AIR fire following model uses the latest fire following research to provide a detailed view of fire following risk
  - Characteristic blocks capture fire spread risk based on realistic building configurations
  - Block distribution model explicitly accounts for open space and building density data
- Fire following research and modeling are advancing, though the significant uncertainty inherent to the nature of fire following will continue to be reflected by uncertainty within the loss results